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9 February 1982

# China Report

## SCIENCE AND TECHNOLOGY

No. 147

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# CHINA REPORT

## SCIENCE AND TECHNOLOGY

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ABSTRACTS

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APPLIED SCIENCES

# GAMMA RAY SPECTRA ANALYSIS OF ATMOSPHERIC FALLOUT FROM 1978 NUCLEAR EXPLOSION

Shanghai HE JISHU [NUCLEAR TECHNIQUES] No 6, Dec 81 pp 11-16

[Article by Liang Yusheng [2733 3254 3932], Wang Gongqing [3769 0501 1987] and Zhang Yiping [1728 1837 5493] of the Shanghai Institute of Nuclear Research, Academia Sinica: "Quantitative Analysis of Distant Region Atmospheric Deposit of Lebris From Nuclear Explosion Using Ge(Li) γ-Ray Spectra," Received 26 Dec 79]

[Text] Abstract

We describe a method and show the measurement results of the radioactive fallout samples collected in Shanghai area soon after the March 1978 nuclear test of China. These environmental samples contain about 20 short-lived γ-emitting isotopes and have very weak radioactivity ($10^{-11} \sim 10^{-9}$curies). Two algorithms are used to determine the peak areas: the Wasson algorithm (WA) for single peaks, and the nonlinear least-squares fitting algorithm without matrix inversion (AWMI) for unresolved peaks. It has been proved successful to apply this combined method to low-level γ-ray spectrum assay.

There are two major difficulties in the qualitative and quantitative analyses of atmospheric fallout environmental sample collected soon after a nuclear explosion; firstly their radioactivity is extremely weak, generally in the $10^{-11}$ to $10^{-9}$ Ci range; secondly they contain at least 20 γ-emitting radioactive elements are most of them shortlived. Analysis by radiochemistry and other methods is very difficult but high resolution Ge(Li) γ spectrometer with large sensitive volume is quite useful in such measurement and total analysis. In foreign countries environmental monitoring and other weak radioactivity measurements also tend to use this method. In this article we describe a method and the measurement results of radioactive fallout samples collected in Shanghai area shortly after the March 1978 nuclear test of China. In the quantitative analysis of the γ-ray spectrum we used a combination of the Wasson algorithm (WA) for single peak areas and the nonlinear least-squares fitting algorithm without matrix inversion (AWMI) for unresolved multiple peak areas and successfully applied it to the γ ray spectrum analysis of very low level samples.

## I. Measurement condition and qualitative analysis

After China's nuclear test in mid-March 1978, the Shanghai Municipal Anti-epidemic Station collected three environmental samples in the city: the first

sample is a large-area fallout sample (precipitant by wet method) collected overa 14 $m^2$ area on the roof of a three-story building during a 20-hour period from 18 to 19 March, the second sample is 11 liters of rainwater collected at the time and the third sample is 900 $m^3$ of air filtered by gas-desolving gel.

We analyzed the samples with a high resolution Ge(Li) detector which has a half-width of 6~7 keV for 1.33 MeV $^{60}Co$ radiation, a sensitive volume of 80 cc and a relative efficiency of 16 percent. In the $\gamma$ ray spectrum of the samples, 60~90 photoelectric peaks can be resolved at the same time. The sample is placed on the detector head and both are enclosed in a cylindrical lead chamber, the sensitivity of detection for each element can be as high as $10^{-11}$ Ci. The measurement time for each sample is 5,000 to 10,000 seconds.

Three criteria are used in qualitative analysis: (1) energy of the photoelectric peak ($E_\gamma$): (2) the $\gamma$ branching ratio (I) of multiple-peaked nuclei; and (3) follow-up measurements are made on the same sample and the half-life ($T_{1/2}$) of its elements are analyzed. The three samples give similar $\gamma$ spectra and qualitative analysis results, each contains at least 60 significant photoelectric peaks belonging to about 21 $\gamma$-emitting nuclei, most of them fission products. The spectrum of one sample must be measured repeatedly in the follow-up in order to resolve the weak long-lived elements that are overshallowed by the strong short-lived elements, examples are $^{144}Ce$, $^{106}Ru$ and $^{124}Sb$, where $^{124}Sb$ is a neutron-actived product discovered in these samples.

## II. Method and results of quantitative analysis

### 1. Determination of peak area N

The Ge(Li) detector has a high energy resolution, characteristic feature of the spectrum--photoelectric peak, or, total energy peak--is very prominent and narrow and its area can be used in the quantitative determination of the $\gamma$ ray intensity. Since the photoelectric peak is superimposed on the Compton plateau of the high energy $\gamma$ ray and the natural background, the number of background events B must be subtracted from the total peak area T to obtain the net peak area N, N = T - B. Hence, the way the baseline is drawn has a large effect on the net peak area N. Because variation in the background spectrum is usually very gradual and the Ge(Li) spectrum peak is very narrow, the baseline under the peak can often be approximated by a straight line. The background area can then be calculated from the trapezoid formula; in this step, the choice of the two end points of the baseline naturally has a bearing on the error in the net peak area N. In treating the background we adopted the so-called "modified baseline graphics" of Wasson.[1] In order to improve the statistical nature of the spectrum we used the following polynomial for a five-point smoothing of the channel counts in the peak area and especially in the vicinity of the two end points that determine the baseline:

$$Y_i^* = [-3(Y_{i-2} + Y_{i+2}) + 12(Y_{i-1} + Y_{i+1}) + 17Y_i]/35 \quad (1)$$

Computation of peak area was done for two cases: single isolated peaks and unresolved complex peaks. For single peaks, the area is determined by summing up the smoothed experimental data. Using Wasson's modified baseline graphical method and subtracting out the background, area is found from the following equations:

$$T = \sum_{i=m_1}^{n_1} Y(i)$$

$$B = (n_1 - m_1 + 1) \cdot \{y(m_2) + [y(n_2) - y(m_2)] \cdot (m_1 + n_1 - 2m_2)/2(n_2 - m_2)\} \qquad (2)$$

$$N = T - B$$

For unresolved complex region of the spectrum, peaks of the $\gamma$ spectrum are resolved by using a nonlinear least-squares curve fitting method.

To describe total energy peaks in the Ge(Li) $\gamma$ ray spectrum, we used the simple model of a Gaussian function:

$$y = y_0 \exp\{-(x - x_0)^2 \cdot 4\ln 2/w_0^2\} = y(x,\ y_0,\ x_0,\ w_0) \qquad (3)$$

where $y_0$ is the Gaussian peak height, $x_0$ is the peak position, $w_0$ is the full width at half maximum (FWHM) and we used the area under the Gaussian to represent the peak area, that is, $N = 1.06 \times y_0 \times w_0$. For the case of overlapped peaks, each peak is fitted by a Gaussian, the summation of p Gaussians is used to fit p overlapping peaks with $p_1 = 3p$ parameters. The iteration method described above is again used in finding the optimum values of the 3p parameters. This method of initial value iteration in solving nonlinear least-squares problem is the widely-used Gauss-Newton method.[2] The general iteration formula is

$$[\delta\alpha_j^{(N)}] = D^{(N)}\left\{\left[\frac{\partial Y^{(N-1)}}{\partial \alpha_j}\right]^T [w_i]\left[\frac{\partial Y^{(N-1)}}{\partial \alpha_k}\right]\right\}^{-1}\left[\frac{\partial Y^{(N-1)}}{\partial \alpha_j}\right]^T [w_i][y_i - Y_i^{(N-1)}] \qquad (4)$$

where superscripts $^{(N)}$ and $^{(N-1)}$ represent the number of iteration. Its weight matrix is diagonal and has elements $w_{ii} = 1/y_j$, adjustment $D^{(N)}$ is:

$$D^{(N)} = \begin{cases} 1 & \text{if iteration is convergent} \\ 0.5D^{(N-1)} & \text{if iteration is divergent} \end{cases}$$

In the Nth iteration, components of the $P_1$- dimensional parameter vector have the following simple fractional form:

$$\Delta\alpha_j^{(N)} = D^{(N)} \sum_{i=1}^{n}\left(\frac{\partial Y_i^{(N-1)}}{\partial \alpha_j}\right) w_{jj}\ (y_j - Y_j^{(N-1)} \Big/ \sum_{i=1}^{n}\left(\frac{\partial Y_i^{(N-1)}}{\partial \alpha_j}\right) w_{jj}$$

$$(j = 1 \cdots\cdots p_1) \qquad (5)$$

We replaced the Gauss-Newton equation with Equation (5) above. This is another algorithm for solving nonlinear least-squares problem and is known as the (fitting) algorithm without matrix inversion (AWMI). The choice of weight factor $w_j$ and $D^{(N)}$ is the same as in the Gauss-Newton algorithm.

Our criterion for iteration convergency is still a steadily decreasing of the following quantity

$$x^2 = R = Q(\vec{\delta a})/(m - p_1) \tag{6}$$

that is, $R^{(N)} < R^{(N-1)}$, or, $\frac{Q(\vec{\delta a}^{(N)})}{m - p_1} < \frac{Q(\vec{\delta a}^{(N-1)})}{m - p_1}$, where m is the number of measurements or, in the case of multi-channel spectrometer, the number of channels in the region of overlapping peaks. $p_1 = 3p$ is the number of parameters, p is the number of peaks, $(m - p_1)$ is the number of degrees of freedom, and superscripts (N) and (N-1) are the indices for two consecutive iterations. Due to limitations in the measurement condition and in the computation, $x^2 = R$ is generally greater than 1. As a quality indicator of the fitting, or, a criterion for terminating the iteration, we choose $R \lesssim 10$ and believe this condition should be adjusted as measured spectra vary greatly and we only fit them with one model, naturally we do not expect the same fitting result. If in special cases the given R value cannot be achieved, then one may output results after a certain set number of iterations (for example, convergent N = 10, divergent z = 10). The computation described above was carried out on a Multi-8 computer programmed in BASIC.

One example of resolving overlapping peaks using this program is the separation of $^{132}$I - 522.6keV, $^{133}$I - 529.5keV, $^{146}$Ba - 537.4keV peaks with $x^2 = 2.6$ for the spectrum taken on 20 March 1978 in large area fallout samples from the March 1978 nuclear test. Results of the resolved peaks are shown in Figure 1. This allowed us to make quantitative analysis on the important signal nucleus $^{133}$I in this nuclear test.

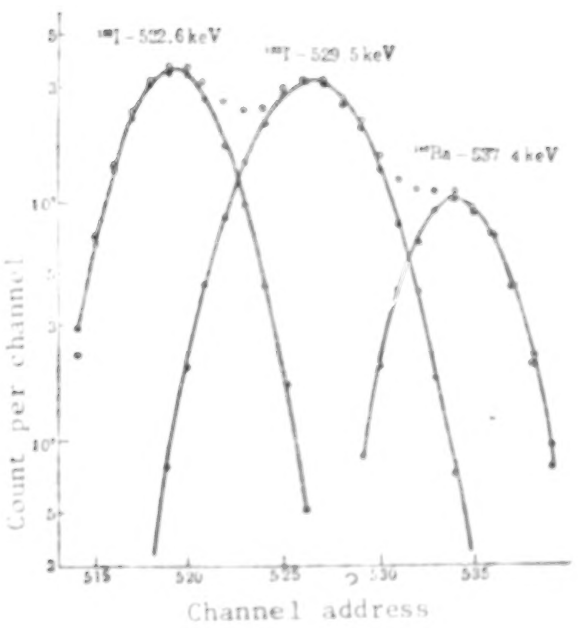



Figure 1. First example: resolving overlapping peaks by AWMI fitting algorithm; open circles are experimental data after smoothing and background subtraction, solid dots are fitted values ($x^2 = 2.6$)
(First spectrum taken on 20 March on distant region large area fallout sample after the March 1978 nuclear explosion)

To test the ability of this algorithm for resolving overlapping peaks, we conducted resolution tests on two "artificial" unresolved spectra to examine the performance of the algorithm in resolving overlapping double peaks and multiple peaks. All the unresolved spectra used were constructed from experimental data of Ge(Li) spectra in the following manner: single peaks were first selected, after smoothing and subtracting out straight line background, they were fitted to a Gaussian and then combined to form overlapping peaks. The AWMI algorithm was used to resolve the multiple peaks and the peak areas were then compared to their original values. The results are shown in Figures 2, 3 and 4.

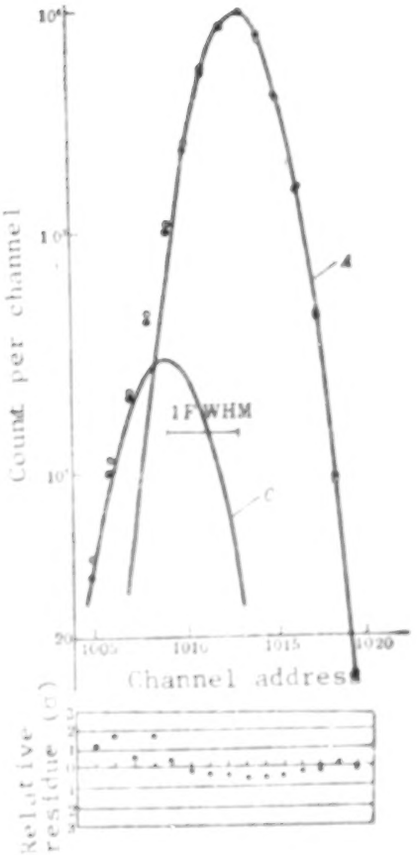



Figure 2. Second example: resolving double peak by AWMI fitting algorithm; open circles represent the sum C + A, (1:2.5), of the originally fitted single peaks, $\Delta x$ = 1 FWHM$\sim$4.3 channels, solid dots represent a fit to the double peak, $x^2$ = 0.94. Area differences from the respective original single peaks are C:-4.31 percent and A:-0.01 percent.

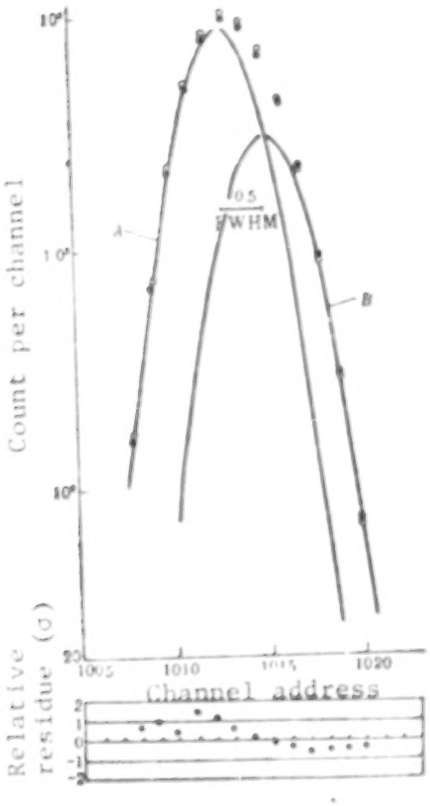



Figure 3. Third example: resolving double peak by AWMI fitting algorithm; open circles represent the sum A + B, (3:1), of the originally fitted single peaks, $\Delta x$ = 0.5 and FWHM$\sim$2.3 channels, solid dots represent a fit to the double peak with $x^2$ = 0.84. Area differences from the respective original single peaks are: A:-1.38 percent and B:+1.84 percent.

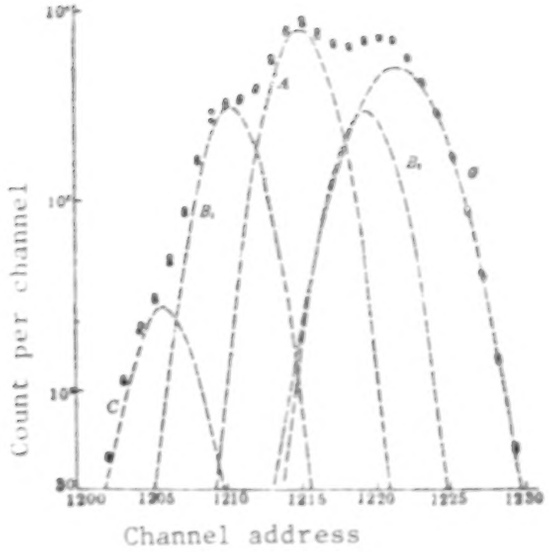
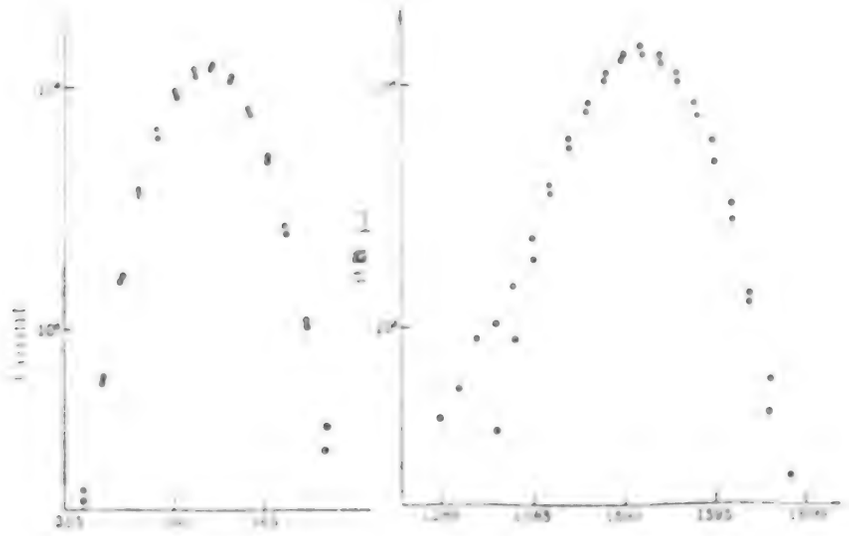



Figure 4. Fourth example: resolving multiple peaks by AWMI fitting algorithm (multiple peaks synthesized from fitted single peaks); open circles represent the sum C + $B_1$ + A + $B_2$ + G of originally fitted peaks and solid dots represent a 5-peak fit with $x^2$ = 4.08. Area differences from the respective original single peaks are: C:-7.72 percent, $B_1$:-0.31 percent, A:-4.12 percent, $B_2$:-0.38 percent and G:+2.13 percent

Figures 2 and 3 show that the results of AWMI resolution are quite satisfactory. Figure 4 indicates that the resolving ability of AWMI for weak peaks is acceptable but when the overlapping peaks are synthesized from unfitted single peaks, considerable errors are introduced due to the deviation of experimental data from the model used.

For a given spectrum, we employed two algorithms in finding the area of the total energy peak. For single peaks we used the Wasson Algorithm (WA) of numerical summation of the experimental data. For overlapping peaks we used the AWMI resolving algorithm of fitting to a function. To see how much the areas from the two methods differ and whether the approach is consistent, we compare the results for a single peak. Using the two prominent single peaks in the $\gamma$ ray spectrum from the first measurement on large area fallout samples, we determined their respective areas using both WA and AWMI and the results are shown in Figure 5. As can be seen, the net peak area obtained from the two algorithms differ by less than 5 percent as long as the experimental data used have all been smoothed (to eliminate wild fluctuations) and the same baseline is used in the two methods. In the quantitative analysis of weakly radioactive environmental samples, this discrepancy between the two algorithms is tolerable and the approximation of the fitting model used is satisfactory. Hence, in the analysis of a given spectrum, we often determine the area of the single peak of a nucleus with the WA method and find the area of the peak in an overlapping region with the AWMI fitting resolution and take the simple average of the quantities of the nuclear species determined from the two methods. As a result, the model error is contained in the results. Although this approach is not entirely rigorous, it is nevertheless a simple and effective method.



Address (a) Address (b)

Figure 5. Comparison of WA and AWMI for simple peak fitting
(a) $^{57}$Co - 194.3keV peak, open circles are experimental data after smoothing and background subtraction (sum = WA area), solid dots are AWMI fitted spectrum ($\chi^2$ = 10.8). The two areas differ by 0.2% percent.
(b) $^{133}$Ba - 1296.6keV peak, open circles are experimental data after smoothing and background subtraction (sum = WA area), solid dots are AWMI fitted spectrum ($\chi^2$ = 2.34). The two areas differ by 3.1% percent. Deviation from a Gaussian in the experimental data is clear.

## 2. Calibration of the photoelectric peak efficiency $\varepsilon_p$

To calibrate the photoelectric peak efficiency, we used a $^{137}$Cs calibration point source at the surface of the detector head to sort the absolute efficiency at 662KeV for the detector used. The $^{137}$Cs source also emits X-rays from $^{137}$Ba. To determine the relative efficiency at energies of the X-rays normalized them to the absolute value at 662KeV and obtained the efficiency curve by interpolation. The result was checked with $^{57}$Co and $^{133}$Ba calibrated sources and the error in the efficiency calibration is estimated to be 5 percent. The calibration curve is shown in Figure 6.

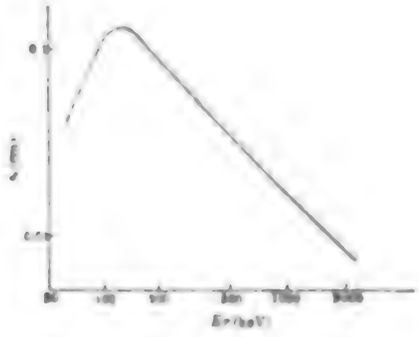


Figure 6. Calibration curve of the detector used in the present experiment. The photoelectric peak efficiency is plotted as a function of energy. The source is placed at the center of the detector head, approximately 1cm from the crystal.

2. Based on the relationship between the yield of fission products and the decay chain, the time of the nuclear explosion may be inferred. Based on the Xu Fenyi [1031 3993] coefficient calculation for the sample, one can deduce whether the test was near ground surface or in the atmosphere and the loading condition. The significance of using two activated products of antimony, $^{125}Sb$ and $^{124}Sb$, as "indicators" still awaits further study. Therefore, $\gamma$-ray spectrum analysis is an important method of reconnaissance and physical analysis for recent atmospheric nuclear explosions.

3. If large area fallout samples are used in estimating the peak fallout rate in Shanghai Area after the March 1978 nuclear explosion, we have the following results:

| 核素 1 | $^{131}I$ | $^{132}I$ | $^{133}I$ | $^{140}La$ | $^{99}Mo$ | $^{103}Ru$ | $^{144}Ce$ |
|---|---|---|---|---|---|---|---|
| 沉降率 2 mCi/km² d | 2.25 | 0.83 | 0.42 | 0.56 | 0.45 | 0.3 | 0.2 |

Key: 1. Nuclear species 2. Fallout rate

The table above shows that the fallout of several radioisotopes of iodine is significant and is worthy of attention from the environmental health protection viewpoint. If continuous measurements were conducted over a longer period of time, then the long-term trend of fallout debris can be observed which would provide a basis for health evaluation of the dosage contribution of various species.

The samples used in this study are collected and prepared by the Shanghai Municipal Antiepidemic Station. The analysis work has benefited from the assistance of the multi-channel group of the Shanghai Institute of Nuclear Research and the contributions [illegible] [1248 1108 6644], Bao Yuhong [0545 1001 3163], Zhang Jiazen [1728 1367 7946], Chen Zhixiang [7115 1807 4328] and Zhang Junlian [1728 1129 1761]. The authors express their sincere thanks.

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YANG YICHEN MEETS SCIENTIFIC PERSONNEL

Shenyang Harbin Heilongjiang Provincial Service in Mandarin 1200 GMT 17 Jan 82

[Excerpts] According to HEILONGJIANG RIBAO, leading comrades of the Heilongjiang Provincial CCP Committee and the provincial people's government, including Yang Yichen, Li Lian, Chen Lei, Li Jianbai, Chen Jianfei and Wang Luming, on 17 January received a number of leading personnel, experts and professors who are attending the provincial work conference on science and technology at the Binhai Building in Harbin Municipality.

After being briefed by (Liang Chengyi), chairman of the provincial scientific and technological committee, on the conference, leading comrades of the provincial CCP committee and the people's government noted: Our province has scored many achievements in scientific and technological work in the past year and has made progress in transforming scientific and technological results into productive forces. The province has also commended advanced scientific and technological personnel who have exerted all-out efforts to score research achievements.

In discussing future tasks, leading comrades noted: Scientific and technological departments should achieve new progress in a new year, and their work results should improve year after year. Efforts should be made to implement the principle that economic construction be carried out in line with science and technology which should be of service to economic construction. This means that we should succeed in integrating scientific research departments with production and higher educational institutions and scientific and technological personnel with the masses to enable science and technology to become a powerful productive force and motive force to accelerate the building of production bases for five undertakings throughout the province.

In concluding, Comrade Yang Yichen, first secretary of the provincial CCP committee, stressed: It is necessary to enhance scientific and technological forces to accelerate economic development. We should stress assigning more scientific and technological personnel among light industrial enterprises. We should transfer some scientific and technological personnel in heavy industrial enterprises to light industry. We should do our best to ferret out personnel not suited to their work. We should attach great importance to training scientific and technological personnel. We should follow the measure to hold training classes for on-the-job cadres and to arrange jobs for trainees to raise the academic level of scientific and technological personnel. We should learn from the experience gained in holding training classes by fraternal provincial cities, including Siping. We should also provide necessary conditions for promoting the scientific and technological forces in our province.

## YANG YICHEN ATTENDS SCIENTIFIC CONFERENCE

SK2004837 Harbin Heilongjiang Provincial Service in Mandarin 1100 GMT 18 Jan 83

(Excerpts) According to our reporter, the Heilongjiang provincial work conference on science and technology concluded today. The conference approved the resolution on successfully tackling key problems in science and technology in order to build the production bases of the five undertakings in line with the four superior conditions in our province.

During the conference, participants, in line with the spirit of the 6th Plenary Session of the 11th CCP Central Committee and the 4th session of the 5th National People's Congress, earnestly discussed the scientific and technological work situation in the province and defined the orientation in developing science and technology and key tasks for our province--successfully tackling key problems in science and technology in order to build the production bases of the five undertakings in line with the four superior conditions in our province. Efforts should be made to popularize scientific and technological results which can promote production, can be applied by most areas throughout the province and can yield economic results.

In conducting scientific and technological work, efforts should be made for new developments. It is necessary to try to achieve a fourth or a third of our new scientific and technological goals. In this end, participants at the conference contended that efforts should be made to do a good job in conducting applied science and popularizing existing scientific and technological results. The conference decided to select for popularization the 81 research projects with the least economic effort among the province's scientific and technological projects receiving awards.

During the conference, leading comrades of the provincial CCP committee and the provincial people's government, including Yang Yichen, Li Lian, Chen Lei, Li Hanbai, Zhou Jiamei, and Wang Luming, received a number of leading personnel, experts and professors. Li Hanbai, secretary of the provincial CCP committee, made a report entitled: "Further Implement the Party's Policy on Scientific and Technological Work To Serve the Program To Achieve Socialist Modernization."

At the conference, the provincial people's government, through careful appraisal, decided to confer on 353 comrades the title senior engineer.

CSO: 4008/79

MICROCOMPUTER SYSTEM MCs PRODUCED IN CHINA

[Article: "EIC-032A Microcomputer System on Mass Production Line"]

[Text] Jointly developed by the Guangzhou branch of China Electronics Import & Export Corporation, Guangzhou Yuanhua Electrical Company and Hong Kong Shida Electronics Company, the EIC-032A microcomputer system has powerful abilities and full variety of peripherals, and is currently produced in massive quantities. It has the following merits:

1. Large Internal Memory Capacity: The mainframe can provide 32 kilobytes of internal memory storage for users alone. It also has 8 kilobytes of RAM for displaying graphs and Chinese characters. Besides, it carries 32 kilobytes EPROM sockets for users to expand on.

2. Powerful Plotting Ability: The EIC-032A has enhanced plotting abilities which many microcomputers do not have. It uses 8 kilobytes of RAM to control 64,000 dots (320 x 200) on a 12 inches screen. It can plot complicated graphs. All kinds of graphic computations and control diagrams can be displayed on the screen, which can, moreover, be reproduced by a plotter with excellent visual effects and accuracy.

3. Ability to Display Certain Amount of Chinese Characters: The capacity of the Chinese word translator is approximately 255 characters, i.e., the maximum number of Chinese words allowed to be used in a program is 255 characters. Moreover, the Chinese characters can be composed with ease and substitution is easy.

4. Rich Softwares: The system comes with expanded BASIC language. More than 10 plotting commands are chained to BASIC. The machine can be equipped with Assembly, PASCAL or LISP in accordance with the user's request. The user also has many other optional software packages to choose from: educational, engineering computation, games, and all kinds of standard programs.

5. Full variety of peripherals: The machine is equipped with magnetic disk unit, printer, plotter, etc. The magnetic disk unit has two drives which support 5 inch floppy disks, each with double density on one side and a 360 kilobytes capacity. The printer can print 132, 96 or 80 characters per line. The highest printing speed is 100 characters per second. The plotter plots on 365 x 260 mm plotting paper; its accuracy is rated at 0.1 mm. The machine can reproduce diagrams in six different colors.

The mainframe CPU65(.) has 1 megahertz clock frequency and 8-bit word length. All the peripherals have their own CPUs.

6. Accuracy in Computation: Computation on the mainframe can be carried up to 9 significant digits; the least/largest values can reach up to ±32 power, which produces a certain degree of precision in all kinds of engineering and scientific calculations.

7. Analog/Digital Converter Options: The mainframe can be configured with multiplex A/D, D/A converters used for industrial control purposes. The specifications and sampling rate of A/D, D/A converters can be made in accordance with the user's requirements.

8. Good Interface: The mainframe carries IEEE-488 interface which can be linked to all kinds of equipment, instruments, meters. It also has 8-bit programmable user's interface and a magnetic tape unit interface.

The ATC-0128 microcomputer system is a comprehensive and inexpensive system (complete set includes mainframe, disk unit, printer, plotter; price 39,000 yuan). It is an all-round microcomputer system for engineering and scientific computation: mathematics, data processing, engineering control, process control, business management, and enterprise management.

CMC-80

Beijing ZHONGGUO JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 77, 7 Dec 81 p 3

[Article: "CMC-80 DUAL-BOARD Microcomputer On Production Line"]

[Text] Recently, the Zhuzhou Electronics Research Institute and Hong Kong Jinshan Company began their joint-venture production of the CMC-80, a Z80 series dual board microcomputer which is more powerful in function than single board models but the same price.

Besides a Z80-CPU and 8 kilobyte static read/write memory, the mainboard also has four EPROM 2716 sockets which allows insertion of 8 kilobyte programs (when out of factory, only one 2 kilobyte program monitoring CMCBUG is installed). It carries a good assortment of input/output interfaces, including four 8-bit parallel programmable I/O interfaces, two synchronous/asynchronous programmable serial communication interfaces, four programmable counter/time channels, eight 8-bit precision A/D conversion channels and one cassette tape interface. This type of microcomputer far excels ordinary single-board microcomputers as far as the variety and quantity of storage capacity or I/O interfaces are concerned.

The auxiliary board has a 28-key keyboard and 6-digital number display for supervising the execution of programs. It is compactly integrated with the mainframe's cables.

The machine is equipped with a program supervisor which supports 16 commands, including such functions as testing and updating storage, register, I/O interface

contents, single step, executing user's program, setting up breakpoint, exchanging information with cassette tape unit, writing EPROM, etc. It can also retain 6 user command keys used for invoking the user's own subprograms.

The CMC-80 has good adaptability for all kinds of applications such as digital control, automatic control, programmable control. It is also an ideal tool for learning computers and as a teaching aid.

## ROLE OF TECHNOLOGICAL SCIENCES DISCUSSED

Beijing ZIRAN BIANZHENGFA TONGXUN [JOURNAL OF THE DIALECTICS OF NATURE] in Chinese No 4, 10 Aug 81 pp 4-6

[Article by Li Peilin [2621 3099 7207] of the Science & Technology Committee of the Fourth Ministry of Machine Building: "The Role of Technological Sciences in the National Economy and Defense Construction in China"]

[Text] 1. Delineation of the Major Stages of Contemporary Science and Technology

Activity in contemporary science and technology can basically be considered to have four key stages: basic science (i.e., basic research), technological science (i.e., applied research), technological development (including what we customarily call prototype manufacture), and concrete engineering technology. The first three stages are clearly characterized by the core goals of discovery, invention, and creativity, and in general by what is called "research and development" (often denoted abroad by the English abbreviation R&D). Here, "scientific research" includes the two stages of basic and applied research.

Concrete engineering technology is wide-ranging. This is using the experience of each domain to raise the level of technical guidance, or what could be called science and technology for everyday use. Examples include the technology of production engineering in industry; planting, plowing, and harvesting technology in agriculture; clinical diagnosis and treatment technology in medicine, etc. Technological development, thus, is a stage inextricably linked to technology for everyday use. It is already a common and important source of contemporary technology for everyday use. It includes aspects from the initial design stage to the development and trial-production of articles. It also includes the overall development and realization of production and operations technology. The clear goal of technological development is to plan on the basis of applied experience.

Basic scientific research is another of the four stages. Its mission is the discovery and description of the natural world's basic phenomena and principles. The new achievements of contemporary basic science have led to many important new technological breakthroughs. For example, the discovery of the Maxwell equations and Hertz' experiments led to the development of radio communications; the discovery of nuclear fission led to the development of nuclear energy and nuclear weapons. The theory of energy transmission in quantum mechanics made

and technology. It was only after WWII that the United States substantially developed basic science. However, since it has such favorable conditions and highly developed economy and a profound degree of applied scientific achievement and engineering technology, it rapidly entered the advanced ranks. During this period Western Europe also began to fill in the thin spots in its own fundamental science. It is also worth mentioning that the United States relied heavily on European talent for the development of its basic science and mathematical science.

Japan is a point among contemporary states of a backward state which has reached the first ranks and attained remarkable development. After WWII, Japan undertook economic, scientific, and technological development. For this reason it could make full use of the achievements of Western European and American science and technology. First, it transferred foreign, especially American, applied engineering and technology, vital to the rapid development of the economy and production. Later, along with copying, it paid full attention to developing its own technology. Because of this they were able thoroughly to master, digest, and even improve imported technology so that many facets of it attained the first ranks. As far as basic science and technological science are concerned, Japan essentially achieved world class results, but did not gain a flourishing level overall. In recent years that have demanded an increase in the rate of technological development and, having already realized their technological revolution and work, they have begun to pay attention to strengthening these two stages.

The historical development of the Soviet Union occurred under different circumstances. Because of court promotion in tsarist times, a foundation for basic scientific research was established early. Building on this heritage, the Soviet Union established the Soviet Academy of Sciences, developed powerful basic science, [illegible] one branch of the world's advanced scientific ranks. Under the conditions of sophisticated military technological development, they [illegible] applied research results. They concentrated talented scientific and technical [illegible] and large material and financial resources on this area, thereby weakening various aspects of applied engineering technology and technological development. This appears to be an important reason why their national economy is restricted in such key sectors as electronics which are characterized by [illegible] in other developed countries. Since high technology and application [illegible] are interdependent and do not make urgent demands on [illegible], fundamental science of course cannot flourish either.

## III. Problems Worth Noting in Science and Technology Development

[illegible] should be properly managed. The United States [illegible] of stress on applying immediate results [illegible] example of concentrating energy on the achievement of [illegible] goals, we cannot follow the old Soviet road of long-term development in isolation. We cannot put long-term development into the background like the United States and Japan. We should take the overall importance of each into consideration. In having [illegible] a period of hesitation in getting results by "[illegible]" long-term research has been neglected. In recent years, attention

APPLIED SCIENCES

CONTINUOUSLY TUNABLE INFRARED LASER [illegible]

Beijing RENMIN RIBAO in Chinese 24 Dec 81 p 1

[Article: "Ma Zuguang Discovers New Continuous Infrared Spectrum"]

[Text] While working at the Institute of Applied Physics of the University of Hannover in West Germany, Harbin Industrial University Associate Professor Ma Zuguang [7456 4371 0342] used a new laser method to discover the first triplet state transition continuous infrared fluorescence spectrum for the diatomic sodium molecule, thus realizing the longstanding objective of scientists.

Currently, guidance, communications and remote control make extensive use of radio waves, but as electronics has advanced, the interference resistance of this type of emissions has become poor. After lasers appeared, high power near-infrared lasers were quickly applied to guidance, communications and other fields. But such lasers can emit only a noncontinuous single-line spectrum and are not continuously tunable as people would wish, so that if the signal can be intercepted by an enemy, it can also be interfered with. Accordingly, scientists in such countries as the United States, West Germany and Italy have been making efforts to find a laser medium which can produce a continuous near-infrared spectrum so as to produce high power continuously tunable lasers. The spectral lines produced by this type of laser are tunable within a certain spectral range. If the signals emitted on one spectral line are detected by the enemy, it is possible to switch immediately to another spectral line and continue emission; this variability greatly increases interference immunity. Experiments have found that Ma Zuguang's discovery meets the requirement. It is of great importance for both military and civilian uses, and has been attracting great interest from West German scientists.

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## SOFTWARE FOR COMPUTATIONAL DYNAMICS DEVELOPED

Beijing RENMIN RIBAO in Chinese 24 Dec 81 p 1

[Article: "Major Achievements in Development of Software for Computational Dynamics"]

[Text] Professor Zhong Wanxie [6988 8001 0533], Associate Professor Qiu Chunhang [5941 2504 5300], instructors Ding Dianming and Li Xiyi and six other young teachers have successfully developed a structural analysis program system (JICFEX) and a structuralizing program language (DITSF) after more than 7 years of arduous labor; this software has already been used in more than 10 engineering construction and management projects in this country and has produced excellent economic results.

Between 12 and 14 December the Ministry of Education held a technical evaluation meeting in Beijing at which it affirmed this achievement, concluding that the JICFEX program system's developers have utilized and improved upon a series of advanced foreign and domestic software development methods and techniques, with the result that the software has a full range of capabilities and a wide range of applications, and is easy to maintain and to transfer to new computer models and convenient to use. The group-theory resolver has greatly improved capabilities and use efficiency and is a development at an advanced international level. Used on minicomputers and microcomputers developed in this country, it can have the effect of "a small horse pulling a large cart" by replacing imported large computers and their program systems.

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APPLIED [illegible]

# [illegible] FORMULA FOR CALCULATING LASER PULSE FORMATION TIME PRESENTED

Shanghai JIGAN KAIXI [KAISER JOURNAL] in Chinese No 1C, 1981 pp 77-78

[Article by Yang Hanqian [2799 3211 0341], Shanghai Municipal Research Institute of Laser Technology: "An Improvement in the Computation of Laser Pulse Formation Time"]

[Text] Laser pulse formation time $T_p$ is an important dynamic parameter in laser theory. A formula for computing it has already been reported [1]:

$$T_p = \frac{1}{\alpha} \ln \left( \frac{\quad} {\quad} \right) \qquad (1)$$

This article uses the same symbols as reference 1. Formula 1 has the advantage of giving relatively high accuracy compared with theoretical values, while its weak point is that computation is excessively time-consuming.

The purpose of this article is to use a more general mathematical formulation for laser pulse formation time and to derive an approximate formula whose computation accuracy is comparable with that of equation 1 but which has the advantage of simple and rapid computation.

First, on the basis of laser oscillation theory, we use an integral transformation similar to that of reference 1 to obtain a general description of the laser pulse time characteristic:

$$t = \int_{x(n_1)}^{x(n)} \frac{dx}{f(x)}, \qquad (2)$$

where the integral variable is:

$$x = -\ln(n/n_1). \qquad (3)$$

and $f(x)$ has the following form:

$$\left[\quad\right]. \tag{5}$$

Equations 1-4 can be applied to any time segment of a laser pulse, rather than dividing the laser pulse into three regions, A, B, and C, for separate treatment as reference 1 does. According to equations 1-4, the time required for the photon number to increase from any value $\phi_1$ to a value $\phi_2$ can be calculated by converting the indefinite integral of equation 1 to a definite integral. Accordingly, in the second step we extend equations 2-4 in a natural way to the computation of laser pulse formation time. According to the definition of laser pulse formation time $t_f$ given in reference 1, we obtain the following formula for $t_f$:

$$t_f = \int_{\phi_0}^{\phi_p} \frac{d\phi}{A(\phi)}. \tag{5}$$

The [illegible] integration for equation 5 are the values of $\phi$ corresponding to the initial photon number $\phi_0$ and the peak value $\phi_p$. The definite integral of equation 5 gives a more general mathematical formula for $t_f$. According to the theory of the integral calculus, it is difficult to obtain a solution for this equation by direct integration. Here an approximation using truncation of the Taylor series expansion of the exponential factor after the first-order term is used to obtain the following approximate expression for the laser pulse formation time:

$$t_f = \frac{1}{\quad}. \tag{6}$$

Here the ratio $\frac{\quad}{\quad} = 1$ may be called the "above-threshold pumping rate." Its physical meaning is clear: it expresses the multiple by which the pumping rate [illegible] pumping rate.

Comparing equation 6 with equation 4, we see that they have a similar form, but in equation 6 the coefficient 0, so that the mathematical [illegible].

[illegible] the accuracy of these results, it is necessary to carry out [illegible] computations and comparison of results. Reference 1 has [illegible] eight laser pulse formation times were calculated for eight [illegible] for different $\tau_1/\tau_2$, the maximum deviation from the theoretical [illegible]. We followed the computation procedure of reference 1, and wrote [illegible] computation time. $T_2$ had a maximum deviation of 0.01 from the [illegible]. The computation results make it clear that the computation [illegible] is equivalent to that of reference 1 or even slightly higher. Equation 6, derived here, is a rather good approximation which, after [illegible] is used. The author expects that it will be useful in [illegible] practical results.

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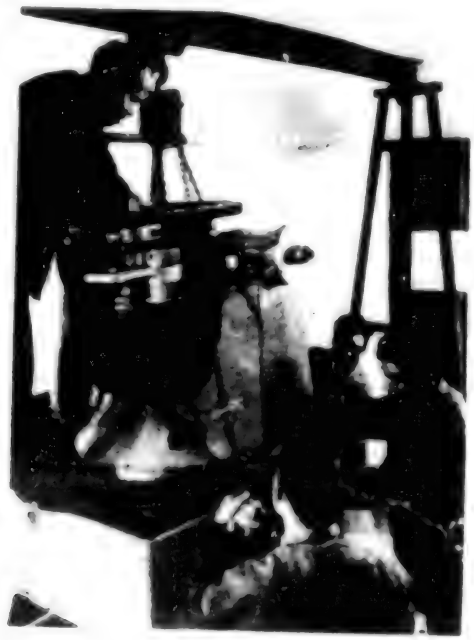
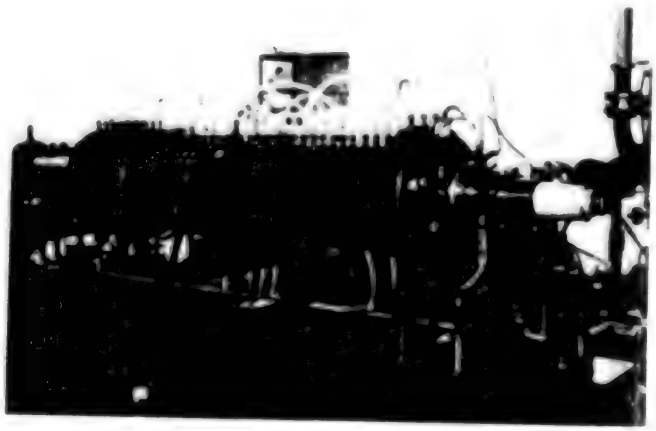
PHOTOS SHOW GUIDED MISSILE SIMULATOR, SYNCHRONOUS RADIATION UNIT

Beijing KEXUE SHIYAN [SCIENTIFIC EXPERIMENT] in Chinese No 1, 1982 inside front cover

[Text]





1. Guided missile simulator being installed by the scientific and technical personnel of a certain Shanghai military plant. It was developed through 10 years of arduous effort, with the vigorous support of related units. The simulator will enable research work on guided missiles to be carried out under laboratory conditions, obviating the need for numerous live tests.

2. China's first synchronous radiation unit. The fabrication and physical design of the Hefei synchronous radiation unit recently underwent evaluation and approval in Hefei. It was developed by scientists and technicians from the University of Science and Technology of China, in cooperation with related units. The synchronous radiological unit is a kind of accelerator which can accelerate electrons to relatively high energy levels to obtain luminous emissions with good characteristics, and thereby provide a powerful tool for basic scientific and point technology research.

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## COMPUTERS NOW IN USE IN PETROLEUM EXPLORATION

Beijing ZHONGGUO JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 23, 5 Dec 81 p 8

[Article: 'Computer Applications in China's Petroleum Exploration']

[Text] As petroleum becomes increasingly difficult to find, the number of discovery wells required for finding an oilfield that is worth developing is also ever on the increase. A discovery well can cost tens of thousands of U.S. dollars at the minimum, or as much as millions or even tens of millions of dollars, which goes to show how steep the rising cost can be. Beginning in the mid-1960's, since the massive application of computers in oil exploration, the average number of exploratory wells per oilfield dropped from 60 in the 1960's to 50 in the mid-1970's. With the development of technology, the number of wells continues to fall gradually.

Our country began using computers for processing oil exploration data in the early 1970's. Also introduced were computers of one million operations per second jointly developed and manufactured by Beijing University, Beijing Wired Broadcasting Equipment Factory and the Petroleum Ministry's Geophysical Exploration Bureau. Digital seismographic instruments, special input devices for seismic data processing, profile plotters, etc. were also successfully developed.

Shengli's Shanghexi Oilfield is a typical example of how data processing is accomplished with computers made in China. Several data processing software packages were gradually perfected as the result of developing programs in the course of geological work. Subsequently, 28 exploratory wells were drilled based on the results of the data processing, and 53 square kilometers of oil-bearing area were obtained in the span of 2-odd years; the results here were better then adjacent areas with similar geological conditions (where digital processing was not used at all. In the latter case, it took more than 10 years to get 31 square kilometers of oil-bearing area). Subsequently, as more and more China-made and imported computers were introduced, seismic data processing techniques underwent continuous improvements which led to the discovery of dozens of new types of oil and gas fields with deeper deposits. For example, seismic data processing played a prominent role in the discovery of north China's ancient cryptomountain oil and gas fields, and fault terrance oilfields. In Sichuan's mountain region, reliable subterranean information leading to the discovery of hidden high-yield gas fields in the eastern and southern parts of the province was obtained as the result of the application of digital processing which greatly enhanced the capacity to conduct seismological research on structures with numerous faults and steep strata. In addition, the application of digital processing also

produced excellent results in the exploration of Bohai Gulf, South China Sea, Jiangsu, Hubei, Xinjiang, etc.

Now, four geophysical data processing centers and more than 20 computerized data processing stations have been set up in China's petroleum system. In 1973, China was still completely dependent on "analog playback" for seismic data; now, computerized digital processing is basically materialized.

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## BRIEFS

MEETING ON TELECOMMUNICATIONS SECURITY--A recent conference on maintaining security on telecommunications lines, convened by the provincial public security department and posts and telecommunications bureau, demanded that the public security and posts and telecommunications departments at all levels, together with the units concerned, seriously do a good job in protecting the lines to ensure a free flow of communications traffic. Henan, located on the central plain, is in a very important communications position. Maintaining communications security within the province is of particularly great importance for maintaining a free flow of communications traffic throughout the province. The departments concerned must uphold the principle of concentrating on prevention and carry out sustained propaganda on protecting the lines. They must launch and rely on the masses to spontaneously protect telecommunications lines. Criminals who sabotage telecommunications lines and block and cut communications must be punished according to law. Such cases must be promptly reported and cracked, and effective blows must be dealt at those responsible. With regard to external accidents that damage telecommunications lines, it is necessary to act according to the relevant state regulations, deal with the matter seriously, find out who is responsible and arrange for compensation for damage, to ensure a secure and smooth flow of communications traffic. Thus telecommunications and communications will be able to play a still better role in building socialist material and spiritual civilization. [Text] [HK160536 Zhengzhou Henan Provincial Service in Mandarin 1100 GMT 15 Jan 82]

[illegible]--according to our reporter [Liang Xiaomin], the regional scientific and technical association held a Spring Festival tea [illegible] on the afternoon of 22 January. Over 200 experts, professors and scientific and technical personnel from universities and scientific research institutes in Hohhot happily gathered together to freely discuss the excellent situation on the scientific and technical front since the Third Plenary Session of the CCP Central Committee and discussed ways to make great contributions to the four modernizations in our region. Comrade Zhou Hui attended and spoke at the tea party. Comrade Kong Fei, on behalf of the regional CCP committee, the regional people's congress Standing Committee, the regional people's government and the regional CPPCC committee, wished scientific and technical workers a happy new year and good health. Also attending the tea party were leaders of the region's party, government and [illegible] including Wang Hai, Wang Tilun, Yun Zhiying, Bu De, Cao Zengpei, Ta Ligong, Wu Linfang, Zhang Ruiqing, Han Fenglin, Qi Junshan, Seyinbayar, Zhou Beiheng, Li Binyan, Bai Bi, Peng Xiao, Wang Jinnong, Liang Yiming, Wang [illegible] and Li Wenjiang. Zhou Beifang and Fu Lipeng also spoke at the party. [illegible], retired veteran cadre of the regional military district, also attended the tea party. [Excerpts] [HK240200 Hohhot Nei Monggol Regional Service in Mandarin 1100 GMT 23 Jan 82]

## BRIEFS

TAIWAN, JAPAN SCIENCE AGREEMENT--Taipei, 20 Jan (CNA)--The Republic of China and Japan concluded an agreement on cooperation in science and technology Wednesday after the end of a 2-day joint conference between two private organizations of the two countries. Chang Kwang-shih, president of the Asia and Pacific Council for Science and Technology, and Masao Maeda, president of the Japanese East Asia Association for Scientific and Technological Cooperation, signed the agreement on behalf of the two sides. The 5-year agreement, effective from 20 February, features exchanges of information, publications on science and technology, an annual convention held in either country, and cooperation between research organizations. The accord will be extended automatically, unless either side notifies the other of its intention to terminate it 6 months before its expiration. [Text] [OW201409 Taipei CNA in English 1346 GMT 20 Jan 82]

CSO: 4008/80

AUTHOR: ZHONG Jinyue [6945 6855 1471]
ZHANG Zeyou [1728 0463 0645]

ORG: Both of the Northeast Normal University

TITLE: "The Buried Peat in the Littoral Areas of China and the Paleogeography of Its Formation"

SOURCE: Beijing HAIYANG YU HUZHAO [OCEANOLOGIA ET LIMNOLOGIA SINICA] in Chinese Vol 12 No 5, 1981 pp 412-421

TEXT OF ENGLISH ABSTRACT: A rather rich peat was buried in the eastern littoral areas of China. Most of it had been formed during the Holocene period. It was not buried very deeply, and there are obvious characteristics of its distribution related to time and space.

1. In the direction of breadth, the peat runs from the north to the south and parallels the coastline, showing the distribution of zone disjointedly. Because of the differences in geometry, it can be divided roughly into two parts. If we draw a line at the mouth of the Qiantang River, there is more peat in the northern part than in the southern.
2. In the vertical direction, most of the peat is being distributed among the three zones of altitude, i.e., 7-15 m, -1 - 6 m and -10 to -30 m sea level.
3. In the horizontal direction, the peat on such altitudinal zones as -1 - 6 m and -10 - -30 m sea level was piled roughly on itself. The former is the top peat; the

[Continuation of HAIYANG YU HUZHAO Vol 12 No 5, 1981 pp 412-421]

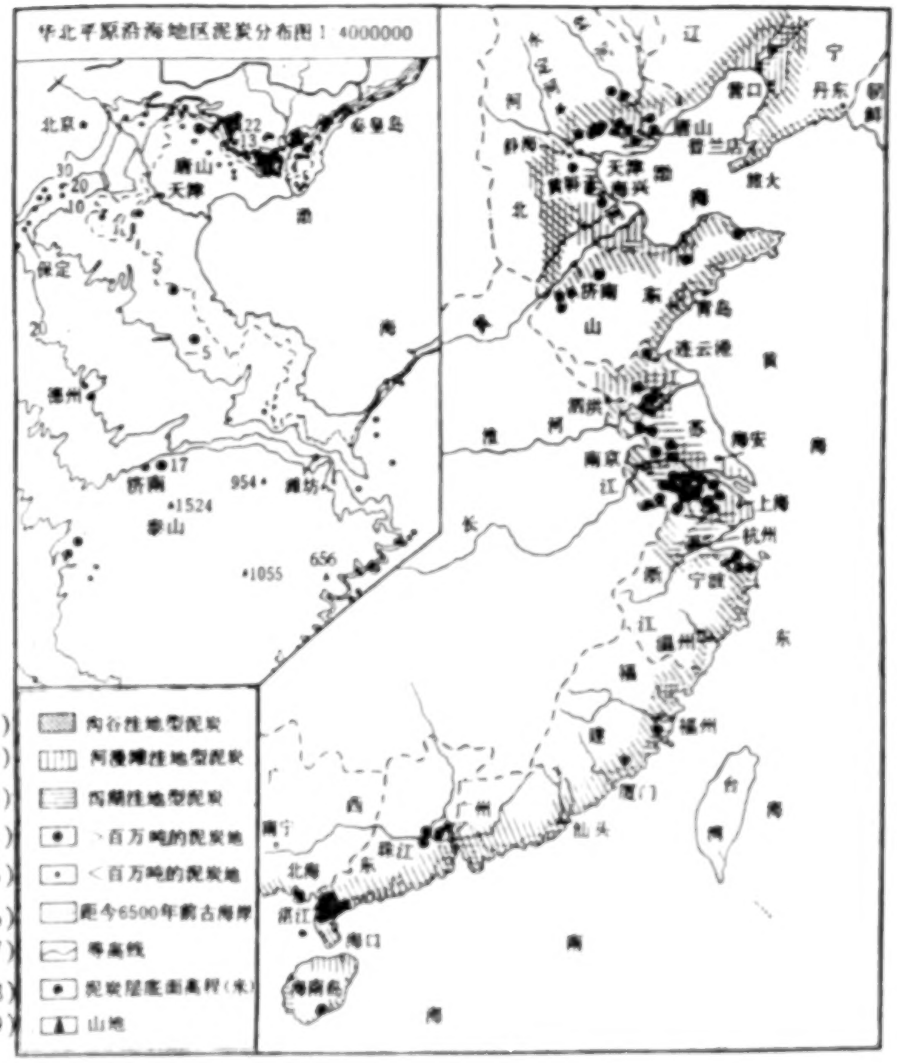
latter is the bottom peat. Both are distributed between the present-day and the old coastlines during the high sea level period. The peat in the 7-15 m sea level is distributed to the west of the old coastline during the high sea level period.
4. As far as time is concerned, the peat in different altitudes was formed in different periods. The peat in the -10 - -30 m level was formed mainly in the early Holocene, that at the 7-15 m level was formed generally in the middle Holocene, and that at the -1 - 6 m sea level was formed in the middle and late Holocene.

The types of the buried peat in the area are chiefly the lagoonal calcipit, the calcipit of alluvial flat and the calcipit gully. Their distributions from the sea to the continent show the regular column from lagoonal calcipit to the calcipit of alluvial flat and the gully calcipit. Roughly, taking the old coastline of high sea level as the boundary, at each side, east and west, there are rows of peat of all three types.

The formation of the peat in the area is mostly influenced by the sea level affecting the hydrodynamics of the continental water. As far as their characteristics of distribution in time and space are concerned, it is the fluctuation of sea level during Holocene that caused the regression and transgression of the sea along the near shore area.

[Continuation of HAIYANG YU HUZHAO Vol 12 No 5, 1981 pp 412-421]

As is well known, peat is the product of swamps. It records both the stage and the degree of its growth. Therefore, the growth and accumulation of the peat in the eastern littoral area in China, which was buried afterwards, clearly reflects the evolution of the old geography of this area.




Legend:

1. Valley depression peat
2. Valley-flat depression peat
3. Lagoon depression peat
4. Peat land > 1 million tons
5. Peat land < 1 million tons
6. Coastline 6500 years ago
7. Contour line
8. Peat stratum basal elevation (meters)
9. Mountain areas

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END

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# DATE FILMED

Feb 10, 1982